

# (12) UK Patent Application (19) GB (11) 2 097 008 A

(21) Application No 8207014

(22) Date of filing 10 Mar 1982

(30) Priority data

(31) 1609/81

(32) 10 Mar 1981

(33) Switzerland (CH)

(43) Application published  
27 Oct 1982

(51) INT CL<sup>3</sup>  
C08G 73/06 C07D 251/70  
C08K 5/34 C08L 77/00

(52) Domestic classification

C3R 35D2 35PX  
C2C 1652 215 247 250  
252 25Y 28X 30Y 321  
322 323 32Y 351 352 456  
45Y 625 640 670 761 766  
809 80Y 814 AA LK NE  
C3K 210 EE  
C3M 104 117 XC  
C3W 310 330  
C3Y F112

(56) Documents cited

GBA 2039505  
GBA 2003485  
GB 1480556  
GB 1393551

(58) Field of search

C2C  
C3R  
C3K

(71) Applicants

Ems-Inventa AG,  
CH—8006 Zurich,  
Stamfenbachstrasse 38,  
Switzerland

(72) Inventors

Manfred Hoppe,  
Eduard Schmid

(74) Agents

Gill Jennings and Every,  
53/64 Chancery Lane,  
London WC2A 1HN

(54) Cyanuric acid reaction products  
and their use in polyamide moulding  
materials

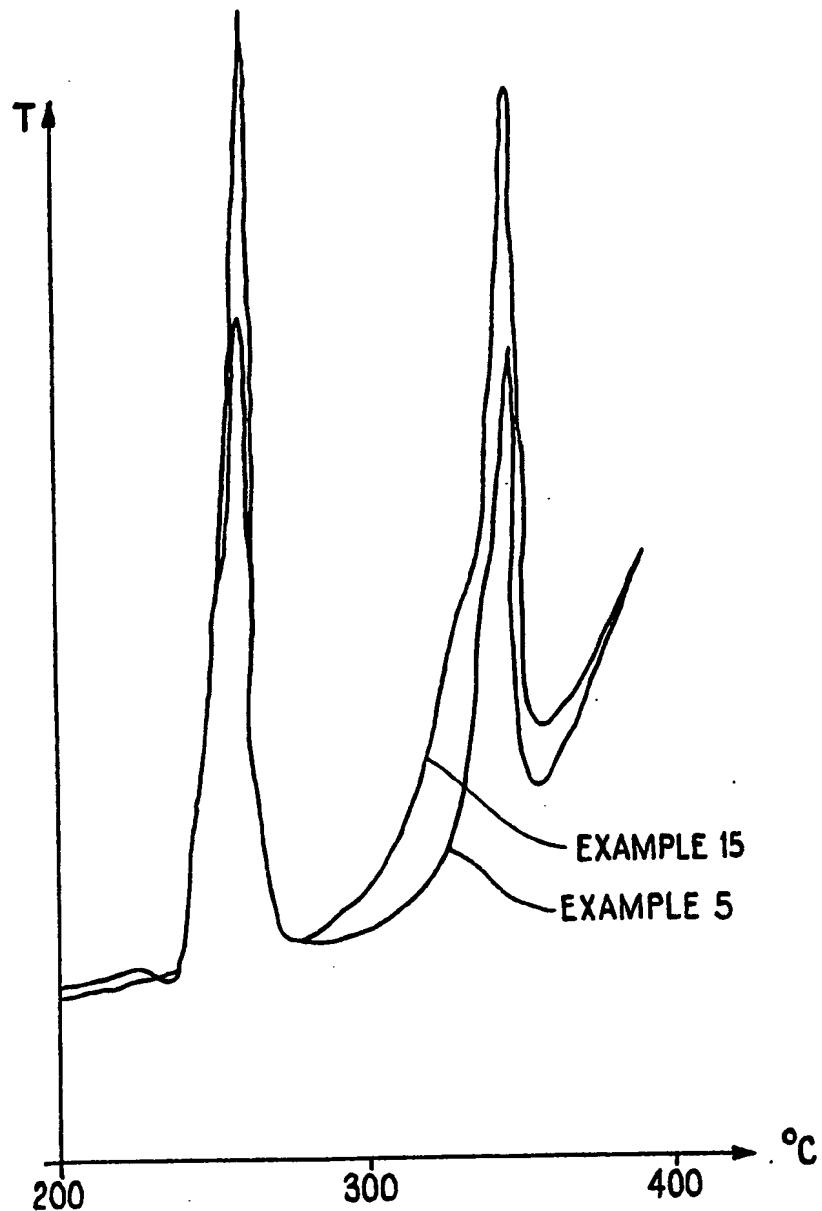
(57) The reaction or condensation  
product of 1 mol cyanuric acid and at  
least 2 mol of nitrogen-containing  
heterocyclic compound can be added

to a thermoplastic material including a  
polyamide to give a flame-proofed  
polymer. The polymer is preferably  
prepared by adding at least 1 mol of  
the heterocyclic compound, e.g.  
melamine, to an intimate mixture of  
the thermoplastic material and a 1:1  
cyanuric acid : heterocycle complex.

GB 2 097 008 A

2097008

1/1



## 1 SPECIFICATION

## Cyanuric acid reaction products and their use in polyamide moulding materials

The invention on hand concerns a non-flammable, thermoplastically processable polyamide moulding material, a process for its manufacture as well as the active flameproofing agent contained therein.

In general, polyamide moulding materials are modified to non-flammability through addition of halogen-substituted aromatic compounds together with finely divided antimony trioxide. The chief drawback of this formulation is the generation of halogen hydracid during combustion, a particularly problematical point in these times of strict environmental protection requirements. Furthermore, such halogen hydracids have an extremely corrosive effect on metal components such as electrical switching elements and electronic parts.

Serious attempts were therefore undertaken to find alternative systems with non-flammable properties without the aforementioned disadvantages.

Thus the use of cyanuric acid and its low alkyl esters, partly in combination with formamide, was suggested in DE—OS 24 53 621 as a flameproofing system for polyamide, whereby only the use of cyanuric acid resp. formamide is disclosed and described according to invention. The description places particular emphasis on the lack of temperature resistance and the difficult processing conditions. Cyanuric acid can thus be used only with copolyamides, low-melting special polyamides resp. very low-viscous polyamide 6-types.

In DE—OS 16 94 254 melamine and malamine substitution products are described as flameproofing agents. These agents influence the mechanical values of the thus treated polyamide moulding material to a but small degree. Temperature resistance of the melamine is good, so that not only polyamide 6 but even polyamide 66 — which has to be processed at high temperatures — can be adjusted to be self-extinguishing. Even in the presence of glass fibres the self-extinguishing properties of the polyamide moulding material are improved.

No mention in abovementioned DE—OS is given to the high sublimation speed of melamine at temperatures over 250°C which leads to deposits in the processing tools and thus to production interruptions, nor to the practically unlimited solubility of melamine in warm water. Due to the (for plastic) high water absorption of polyamide 6 and polyamide 66, the flameproofing agent melamine is washed out of the corresponding moulded parts if they are in contact with water for longer periods of time, resulting in a loss of the flameproofing effect. In addition, the aforesaid high sublimation tendency of melamine causes blooming on the surfaces of moulded parts, which in turn influences the electrical properties.

DE—OS 27 40 092 describes a flameproofing system which circumvents essential drawbacks of the abovementioned patent publications. It describes as active flameproofing agent the defined addition compound of melamine with cyanuric acid, which is produced through reaction of cyanuric acid with melamine at a mol-ratio of 1:1. According to abovementioned DE—OS, this flameproofing agent is of low solubility even in warm water. It is produced e.g. by mixing an aqueous solution of cyanuric acid with an aqueous solution of melamine and transforming the same at approx. 90—100°C with agitation, whereby the precipitation is filtered away. Unfortunately, the temperature resistance provided by this melamine cyanurate is not sufficient for polyamides such as polyamide 66 which are processed at high temperatures. In this context DE—OS 27 40 092 states on page 13, lines 6—9, "It is advisable to heat the material in the moulding stage to a temperature under 270°C and in particular under 250°C to prevent distintegration of the flameproofing agent". In practice it has thus become apparent that pure polyamide 66 cannot be modified with melamine cyanurate as flameproofing agent. To be able to exploit the advantages of melamine cyanurate to a certain extent also with polyamide 66, lower-melting copolyamides of polyamide 66 were used with polyamide 6. However, they have a significantly reduced thermoforming resistance as well as reduced rigidness, and thus no longer the specifically advantageous properties of polyamide 66.

Nevertheless, due to its outstanding properties polyamide 66 is the most popular construction material in the polyamides class, and holds the biggest market share. Its advantages are: high thermoforming resistance, with a particularly positive effect on the mineral-filled or fibreglass-reinforced types, very quick processing cycle and outstanding mechanical as well as electrical properties. There exists thus a high demand for a polyamide 66 suited to electrical and electronic applications (i.e. modified without halogen) with good self-extinguishing properties.

DE—AS 11 73 641 describes the utilization of elementary red phosphorus for the flameproofing of thermoplasts, and also of polyamide. It proved to be principally possible to incorporate red phosphorus, also into polyamide 66, and self extinguishing properties were able to be achieved. However, special precautionary measures have to be taken on account of the extremely high reactivity of elementary phosphorus during its manufacture and incorporation into the polymer. This has led to a wide range of papers dealing with the stabilization, i.e. the reduction of reactivity of red phosphorus, e.g. US—PS 3,951,908 in which an encapsulation of the red phosphorous in caprolactam is described, or the data sheet phosphorus products, EXOLIT 505 of Farbwerke Hoechst, Knapsack works, FRG dated 05/76, in which the processing of such caprolactam-encapsulated red phosphorus with polyamide 66

for the manufacture of flame-resistant materials is described. The literature shows that work must be carried out under inert gas, and that the workrooms must be equipped with special ventilation systems to ensure that any poisonous phosphines can be effectively eliminated. In addition, the resulting products are of an intensive brown colour, for which reason (except for black dyeing with soot black of very high covering power) practically no further colours are possible.

5

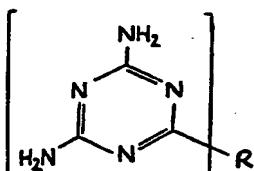
The systems employing elementary phosphorus therefore also do not represent a satisfactory solution.

Surprisingly flameproof, thermoplastically processable polyamide moulding materials have now been found, which do not have the abovementioned drawbacks. The polyamide moulding materials of 10 the invention are characterized by their consisting of a thermoplastically processable polyamide or polyamide mix or of a blend of polyamide and a further thermoplastically processable plastic and of the transformation product of 1 mol cyanuric acid and 2 mol of a basic nitrogenous heterocyclo.

10

It is of advantage if the material quota is made up in full of polyamide, whereby the 97—70 parts by weight of polyamide are supplemented by 3—30 parts by weight of aforementioned transformation 15 product. The basic nitrogenous heterocyclo, which functions as one component of above-listed transformation product, is preferably a single or multinuclear compound of formula

15



in which the R = —NH—R, and R and R, each stand for an organic residue and R, additionally denotes hydrogen. Insofar as R or R, represents an organic residue this means e.g. an aliphatic or araliphatic one 20 such as the benzyl residue, whereby such residues can also be further substituted, amongst others with the triazinyl residue depicted in square brackets of formula I, leading to multi-nuclear triazinyl compounds; the melamine-formaldehyde condensates, familiar from melamine resin chemistry, also belong in this group.

20

However, R = NH<sub>2</sub> is preferable, and thus the preferred nitrogenous heterocyclo is melamine. 25 All thermoplastically-processable polyamide types can be employed as polyamides. Of particular advantage is, of course, the use of the high-melting polyamide types as well as of highly viscous polyamide types which, due to their high melting viscosity, require high processing temperatures. Relevant examples are polyamide 66, the polyamide of isophthalic acid and hexamethylene diamine, transparent polyamides of US—PS 4,232,145 (or DE—OS 26 42 244) as well as generally all 30 transparent polyamides with glass transformation temperatures over 150°C, then the polyamide blends, e.g. of polyamide 66 with other polyamides, in particular with transparent polyamides with a glass transformation point over 150°C, or of amorphous polyamides with a glass transformation point over 150°C with any type of other polyamides.

30

In addition, so-called polymer alloys, i.e. intimate mixes of two or more polymers, can be 35 flameproofed with the compound of the invention on hand, whereby at least one component of the alloy has to be a polyamide. Such alloys, or polymer blends, consist e.g. of polyamide and a polyester, e.g. polyamide 66 and polybutene terephthalate or polyethylene terephthalate. A further example is polyamide 66 with polyethylene terephthalate as well as with an olefinic copolymerisate, e.g. polyethylene and acrylic acid. Here the acrylic acid can be partially neutralized and may contain metal 40 ions such as Na, Zn, Ca, Mg, Pb etc. in place of the acid proton. Such olefinic polymerides are known under the name "ionomers". Further examples are polymer alloys of polyamide 6, 66 or 12 with a transparent polyamide, e.g. as in US—PS 4, 232, 145 as well as an ionomer resin or polyamide 12 with polyethylene terephthalate and an ionomer resin. If olefinic polymers or copolymers are also used as 45 alloy components, they should be as far as possible free of double bonds.

40

The polyamides, polyamide alloys or the polymer alloys can, of course, be given conventional processing auxiliaries, stabilizers as well as filler and reinforcing agents and further additives, e.g. plastizing agents such as metal stearate, release agents such as polyethylene waxes, heat stabilizers, e.g. the cupriferous combinations familiar from polyamide processing, or sterically-hindered phenols, or light stabilizers such as benztriazoles, or finely dispersed soot, furthermore fillers such as kaolin or 50 reinforcing agents, e.g. glass or pigments or dyes. It goes without saying that these additives can be employed also in various combinations.

50

In these materials the transformation product as defined should be present in as finely dispersed form as possible.

The fact that the compound of 1 mol cyanuric acid and 2 mol melamine (so-called 55 "dimelaminecyanurate") has such a high processing stability permitting excellent processing and, at the same time, flameproofing of polyamide 66 and in this case also of the high-viscosity types is surprising. Furthermore, if the concentration is suitably selected, the flameproofing agent remains

55

effective even if subjected to warm water. In addition, the mechanical and electrical properties of the thermoplastic materials are hardly influenced. Processability and in particular the injection cycle of polyamides modified with this compound are excellent. Dyeing in many colours is simple as the flame-proofing agent has only small inherent colour.

- 5        The active agent is described in the invention on hand, dimelaminecyanurate, has extraordinarily interesting properties. It is produced preferably according to the process described in detail in the following during incorporation into the polyamide, by incorporating 3—30 parts by weight of an intimate mixture of melamine:cyanurate 1:1 with at least 1 mol of melamine directly into 97—70 parts by weight of the polyamide melt in particular into polyamide 66. 5
- 10      For this purpose, the first step is the manufacture of the melamine cyanurate 1:1 according to aforementioned DE—OS 27 40 092 and its fine pulverization. Then the melamine cyanurate 1:1 is homogeneously mixed with finely ground melamine, e.g. in an intensive mixer such as the Henschel-mixer. Next the mixture is worked into the polyamide melting through intensive kneading, e.g. in a double-arm kneader such as the ZSK 30 manufactured by Werner & Pfleiderer, Stuttgart/FRG. With a 10 polyamide of low melting viscosity this can be done without further additives. If a polyamide of medium or high viscosity is used the addition of a plasticizer is recommended, e.g. a so-called metal soap (calcium stearate or magnesium stearate). 15
- 15      Other effective processing aids are amides such as the amide from tridecyl-amine and lauric acid, bisamides such as ethylenebisstearamide, also bisureides or simple amines with long-chain alkyl residues which can be linear or branching and containing e.g. 12—30 C-atoms. A selection of suitable 20 plasticizing and processing aids is given e.g. in the previously mentioned DE—OS 27 40 092.
- 20      The melamine:cyanurate 1:1 is worked into the polyamide, preferably in finely broken-up form. It affords the polyamide material advantageous non-flammable properties. Advantages are also to be found in the improved temperature stability, so that polyamide 6 of medium and high viscosity can also 25 be processed without problems, as well as its only slight solubility in warm water in particular. During processing sublimation effects are hardly encountered, and in conditions of high temperature and humidity only a very small degree of blooming is to be observed. This means that the electrical properties remain to a very large extent uninfluenced. 25
- 25      Whilst in the melamine:cyanurate 1:1 only a functional group of the cyanuric acid has reacted with 30 melamine, a second functional group of the cyanuric acid additionally reacts with the extra melamine in the case of the 1:2 compound. Cyanuric acid exists in keto and enol form; in which forms the linkage is chiefly extant is difficult to define. However, the result is important, namely the fact that a stabilization of the flameproofing system is achieved through the additional linkage, enabling problem-free 35 processing also of polyamides requiring high processing temperatures, in particular of polyamide 66, to be carried out. 35
- 30      The fact that a linkage is created is clearly depicted by the unequal course of the DTA curves from example 5 and comparison example 15 in the critical temperature range of 280—350°C, whereby it becomes apparent that, when using melamine:cyanurate 1:1, transformations combined with heat tones proceed immediately above the melting point of the polyamide 66, whilst in the case of the 40 transformation product as defined, produced in situ, such reactions do not occur until significantly higher temperatures, of over 300°C, are reached (see fig. 1). 40
- 40      When solutions of melamine and cyanuric acid are brought together, even if an excess of melamine is present, the aqueous solution thus achieved loses the 1:1 compounds as they are the least soluble ones in this medium. The process via mixing of melamine-cyanurate 1:1 with finely broken-up 45 melamine for the production of the 1:2 compound is effected most advantageously directly in situ, i.e. in the polyamide melting. This has proven to be the simplest and cheapest method. However, two points must be observed; firstly, an intensive premixing of the components and secondly, an apparatus permitting highly effective kneading of the polyamide melting which contains the additives. When using high-viscosity polyamides it is therefore advisable to include an effective plasticizer. 45
- 45      Polyamide materials produced in this manner can be subsequently processed into moulded 50 objects of any kind without any problems.
- 50      If the resulting moulded objects are subsequently conditioned in warm water or if a longer period of contact with warm water is experienced, the second linkage of the cyanuric acid with the melamine is dissolved and a mol of melamine is released. This can be visualized as follows; instead of the melamine 55 water (links) via a hydrogen bridge bond and the cyanuric acid is deposited and the melamine is displaced. This is in accordance with the fact that cyanuric acid crystallizes out of water in form of the dihydrate. The released melamine can now be extracted with warm water. The remaining 1:1 compound, the melamine-cyanurate 1:1, is stable towards splitting up with water, of low solubility and thus remains in the polyamide matrix as an effective flameproofing agent. 55
- 55      If e.g. polyamide 66 is modified for non-flammability with 10 weight % of the product of the invention on hand and the product is subsequently exposed to warm water, the flameproofing effect is retained thanks to the melamine:cyanurate 1:1 still extant in the matrix. 60
- 60      In cases where the extractable melamine is not desirable, the melamine can be replaced by oligomers, multinuclear melamine compounds of low solubility in water, e.g. 2—10-nuclear melamine-65 formaldehyde condensates. The products must be condensed so that at least 1 NH<sub>2</sub> group for the 65

formation of the addition compound with the cyanuric acid remains from the original melamine ring. If this procedure is carried out, it is of advantage to insert a certain surplus of (condensed melamine rings) per mol of melamine cyanurate as the melamine rings lose a part of their mobility as a result of the co-condensation and thus react with the cyanuric acid to a somewhat reduced extent.

5 The following examples are illustrative of the invention. 5

Abbreviations used:

Mel	—	melamine	
MC	—	melamine-cyanurate	
PA	—	polyamide	
10 PBTP	—	polybutylene terephthalate	10

Other abbreviations used in the tables are explained on the corresponding pages.

#### EXAMPLES

##### General procedure

In the following examples and comparison examples the flameproofing agents Mel, MC, MC and

15 Mel were worked into various polyamides, polyamide blends or polyamide alloys. 15  
Before working in the flameproofing agent acc. to the invention on hand the MC and Mel was intensively premixed in as finely broken-up form as possible in an intensive mixer, e.g. the Henschel laboratory mixer.

To achieve optimum distribution of the flameproofing agent during the working-in process a 20 plasticizer was usually also employed. 20

A double-arm kneader Werner & Pfleiderer, Stuttgart/FRG type ZSK 28 was used to incorporate the additives.

As preparation for the working-in of the flameproofing agent the granulate of polyamide (or 25 granulate mixture if a polyamide blend or a polyamide alloy was used) was first powdered with the release agent and then intensively mixed with the flameproofing agent. This mix was subsequently fed into the double-arm kneader through a feed hopper, whereby the double arms were kept at a speed of approx. 150 rpm, and the melting in the extruder showed a material temperature of approx. 280°C. The melting was drawn out via a water bath in cord form, and the cord was subsequently granulated. The resulting chips were dried to a water content of approx. 0.05 weight% and then processed on a plunger-type injection moulding machine to flat rods 12 cm long and 1.3 cm wide. The thickness of the rods was 30 0.8, 1.6 or 3.2 mm. Burning behaviour was then determined by the UL 94 method (standard of Underwriters Laboratories Inc., Melville USA). 30

#### EXAMPLES 1—10 (table 1)

Procedure as described in "General Procedure", whereby MC or mixtures of MC with Mel were 35 worked into PA66 or other polyamides or an alloy of PA with PBTB. 35

The results are summarized in table 1. They show that with MC or mixes of Mel and MC which are under the stoichiometric ratio of 1 mol Mel per MC no perfectly processable PA 66 material can be produced. If the ratio of 1 is achieved (or slightly exceeded for practical reasons) objects of PA 66 can be perfectly obtained, whereby their flameproof properties depend on the amount of flameproofing agent 40 used, achieving UL 94 classification VO even with e.g. 10 weight% flameproofing agent (example 5) and even with rods of 0.8 mm thickness. 40

Examples 6—10 refer to further polyamides or blends perfectly processable only at high material temperatures. All of them were able to be processed into perfect test objects with good, self-extinguishing properties.

45 Abbreviations used in the following tables 1 and 2: 45

1)	—	comparison example	
CaS	—	calcium stearate	
A	—	aliphatic primary amine (mol wt 267)	
V2	—	extinguished	
50 VO	—	self-extinguishing, best non-flammability class	50
NK	—	non-classifiable, i.e. poor effect	

TABLE 1

Example	Type	Polymer	Specification	Flameproofing agent in weight %		Processing aids	UL-94 classification test object, thickness, mm				Remarks	
				Mel	MC		Mel:MC	type	wt. %	0.8	1.6	
1*	PA-66	medium-viscosity injection moulding type		0.5	8	1:7.9	A	0.5				Foaming and serious surface flaws during processing
2*	do	do	do	2.0	8	1:1.97	A	1.0				do
3*	do	do	do	3.0	5	1.22:1	A	1.0	V2	V0	V0	Flawless surface up to material temp. 300°
4	do	do	do	4.0	6	1.35:1	CaS	0.3	V0	V0	V0	do
5	do	high viscosity for injection and extrusion	4.0	7	1.16:1	do	0.3	V2	V0	V0	V0	do
6	Amorph'CoPA acc. to US 42321 45, example 23	high viscosity	4.0	6.0	1.35:1	do	0.3	V0	V0	V0	V0	do
7	PA of isophthalic acid + diaminohexane	high-viscosity extrusion type	4.0	7.0	1.16:1	do	0.3	V0	V0	V0	V0	do
8	CoPA of 85% caprolactam + 15% laurolact	as ex. 1, medium inj. moulding type	4.0	7.0	1.16:1	do	0.3	VZ	V0	V0	V0	do
9	Pa-66, 80% PBTP 20%	—	4.0	7.0	1.16:1	do	0.3	V2	V0	V0	V0	do
10	Amorph' PA acc. to ex. 6 + PA 66 acc. to ex. 2, 1:1	—	4.0	7.0	1.16:1	do	0.3	V2	V0	V0	V0	do

## COMPARISON EXAMPLE 11 and COMPARISON EXAMPLE 12 (Table 2)

12% Mel were worked into a PA 66 as in examples 1—5, of which flat rods 1.6 mm thick were subsequently produced for the burning test. The material shows self-extinguishing properties corresponding to UL 94, VO, at 1.6 mm. These rods, together with rods from example 5, were then 5 immersed in boiling water for 4 hours and then each subjected to a burning test acc. to UL 94. The results are compiled in the following table:

TABLE 2

Example No.	PA-type	Flameproofing agent		UL classification, 1.6 m flat rod
		Mel	MC	
11 comp. example	PA 66 corresp. to ex. 1—5	12	—	NK
12 example		4	6	VO

Table 2 shows that Mel is a water-extractable flameproofing agent, whilst if the system of the invention on hand is used the flameproofing effect is retained even after a longer period of contact with 10 boiling water.

10

## EXAMPLE 13

Solid objects were produced out of PA 66 adjusted to be self-extinguishing as in example 5, for which the mechanical properties in comparison with the same PA basic type, however without flameproofing agent, were then determined (see table 3).

15 It became apparent that the polyamide 66 of the invention on hand and corresponding to example 15 13 does not differ significantly from the unmodified PA 66. it showed practically identical strength values corresponding to DIN standard 35455, has the advantage of an increased degree of rigidity (DIN 53457 and DIN 53452) and hardness (DIN 53456). On the other hand, however, tenacity (strength) is somewhat lower (DIN 53453). Of importance in this context is that the good value for oB (oB = without 20 break) is achieved in the conditioned state for impact strength, a characteristic significant for practical application.

20

In addition, the burning test of ASTM D 2823 was carried out on the PA 66 of the invention on hand, with a resulting value for % O<sub>2</sub> of 33 (LOI value).

TABLE 3

Characteristic	Standard	Unit	Mechanical values			
			PA66 corresp. with ex. 5		Pure, medium- viscosity PA basic type	
			dry	cond.	dry	cond.
Yield strength	DIN 53455	N/mm <sup>2</sup>	90	45	85	55
Yield elongation	„ „	%	<5	<5	<5	25
Breaking strength	„ „	N/mm <sup>2</sup>	85	50	85	45
Breaking elongat.	„ „	%	5	25	15	175
Tension-E-module	DIN 53457	N/mm <sup>2</sup>	3000	1700	3600	1600
Bending stress	DIN 53452	N/mm <sup>2</sup>	130	55	120	50
Bending-E-module	„ „	N/mm <sup>2</sup>	3000	1300	2500	950
Ball imp. hardness 30"	DIN 53456	N/mm <sup>2</sup>	130	65	95	50
Shore hardness D	—	—	83	75	95	75
Impact strength 23°	DIN 53453	kJ/mm <sup>2</sup>	50	oB	oB	oB
Impact strength when notched 23°	„ „	kJ/mm <sup>2</sup>	2	5	4.5	12

**EXAMPLE 14 (= PA as in example 5) and COMPARISON EXAMPLE 15**

In this example the processability of PA 66 with flameproofing agent corresponding to example 5 was compared with PA 66, containing 10% MC as flameproofing addition. For this purpose plates with an edge length of 10 cm and a thickness of 3 mm were injected at temperatures of the polyamide

**5 melting between 270 and 300°C and then compared as to surface quality.**

The results are compiled in table 4. They show that using the flameproofing agent of the invention on hand and up to a material temperature of 300°C (the highest tested temperature, usually used for the processing of PA 66) plates with perfect surface quality can be obtained, whilst it was not possible to obtain perfect plates through modification of the same PA 66 type with MC.

5

**TABLE 4**

Example	Material temp. of the PA-melting °C	Assessment of the test objects
14	275	very good
	280	do.
	290	do.
	300	do.
15 (comp. example)	275	slight surface flaws
	280	distinct surface flaws
	290	serious surface flaws
	300	very serious signs of disintegration

**EXAMPLES 16—19**

In the following examples and comparison examples of table 5, 30% mineral as well as the flameproofing system of the invention on hand in a concentration of 15 weight% was worked into PA 66 (injection moulding type of medium viscosity), whereby 9 weight% MC and 6 weight% Mel were 15 used. At a material temperature of 280—290°C rods were produced therefrom corresponding to examples 1—10, then their self-extinguishing properties by UL 94 were determined.

15

On each rod (all had a perfect surface) the classification VO was measured up to a layer thickness of 1.6 mm. At the same time small DIN beams were injected therefrom on which the bending and impact values were determined according to DIN 53453.

**20 As shown in table 5, these self-extinguishing formulations based on PA 66 are significantly stiffer than the PA 66 only equipped with flameproofing agent.** 20

TABLE 5

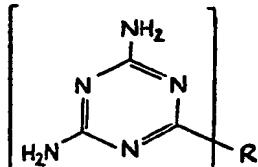
Example No. (* = comp. example)	Mineral	Mechanical values			
		Impact strength DIN 53453	Bending stress DIN 53452 dry	Bending E-module dry	Ball imp. hardness DIN 53456 dry
16	Alum. silicate, ground to av. $\phi$ of $1.2\mu$ , kaoline type of Messrs. Engelhard, Edison N.J./USA	20	205	4700	190
17*	— as above —	40	197	4500	185
18	Calcium metasilicate to av. grain size of $10\mu$ of Messrs. Interpan, Willsboro/USA	16	220	4900	190
19*	— as above —	21	205	4600	187
without flame-proofing agent					

## CLAIMS

1. The reaction or condensation product of 1 mol cyanuric acid and at least 2 mol of a nitrogen-containing heterocyclic compound.

5 2. A product according to claim 1, in which the heterocyclic compound is a monocyclic or multicyclic compound of the formula

5



wherein R is NHR, or an organic residue and R<sub>1</sub> is hydrogen or an organic residue.

3. A product according to claim 1, in which the heterocyclic compound is melamine.

10 4. A product according to claim 1, substantially as herein described.

5. A moulding material which comprises a thermoplastic material including a polyamide and a product according to any preceding claim.

6. A material according to claim 5, which comprises from 97 to 70 parts by weight of the thermoplastic material and from 3 to 30 parts by weight of the said product.

15 7. A material according to claim 4 or claim 5, in which the polyamide has a processing temperature of over 270°C.

8. A material according to claim 7, in which the polyamide is polyamide 66.

9. A material according to claim 7, in which the polyamide is an amorphous polyamide of isophthalic acid and diaminohexane.

20 10. A material according to claim 7, in which the polyamide is an amorphous polyamide as claimed in DE—OS 26 42 244.

11. A material according to any of claims 5 to 10, in which the thermoplastic material consists of one or more polyamide.

12. A material according to any of claims 5 to 10, in which the thermoplastic material comprises 25 one or more polyamides and a further thermoplastic substance.

13. A material according to claim 5, substantially as herein described.

10

15

20

25

14. A process for preparing a moulding material according to any of claims 5 to 13, which comprises adding at least 1 mol of the heterocyclic compound to an intimate mixture of the thermoplastic material and a 1:1 reaction product of cyanuric acid and the heterocyclic compound.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office.  
25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained

**THIS PAGE BLANK (USPTO)**